

WHAT IS CLAIMED IS:

1. A photoelectric conversion device comprising  
at least an electron acceptive charge transfer layer,  
an electron donative charge transfer layer, and a light  
5 absorption layer existing between the charge transfer  
layers, wherein either one of the charge transfer  
layers is a semiconductor acicular crystal layer  
comprising aggregate of acicular crystals.
- 10 2. The photoelectric conversion device according  
to claim 1, wherein the diameters of the acicular  
crystals are 1  $\mu\text{m}$  or less.
- 15 3. The photoelectric conversion device according  
to claim 1, wherein an aspect ratio of the acicular  
crystal is 5 or more when the aspect ratio is defined  
as the ratio of the length to the diameter of the  
acicular crystal or as the ratio of the length of the  
acicular crystal to the length of a shortest line in a  
20 transverse cross-section passing the gravity center of  
the acicular crystal.
- 25 4. The photoelectric conversion device according  
to claim 1, wherein an aspect ratio of the acicular  
crystal is 10 or more when the aspect ratio is defined  
as the ratio of the length to the diameter of the  
acicular crystal or as the ratio of the length of the

acicular crystal to the length of a shortest line in a transverse cross-section passing the gravity center of the acicular crystal.

5           5. The photoelectric conversion device according to claim 1, wherein the semiconductor acicular crystal layer is provided on a substrate, one end of the acicular crystal forming the semiconductor acicular crystal layer is bonded to a principal plane of the  
10           substrate, and the angle formed between the axial direction of the acicular crystal and the principal plane of the substrate is 60° or more.

          6. The photoelectric conversion device according to claim 1, wherein the semiconductor acicular crystal  
15           layer is provided on a substrate with an electrode, one end of the acicular crystal forming the semiconductor acicular crystal layer is bonded to the electrode, and the angle formed between the axial direction of the  
20           acicular crystal and the principal plane of the substrate is 60° or more.

          7. The photoelectric conversion device according to claim 1, wherein the light absorption layer  
25           comprises dye.

          8. The photoelectric conversion device according

to claim 1, wherein the acicular crystals comprise a metal oxide.

9. The photoelectric conversion device according  
5 to claim 8, wherein the acicular crystals comprise titanium oxide.

10. The photoelectric conversion device according  
to claim 8, wherein the acicular crystals comprise zinc  
10 oxide.

11. The photoelectric conversion device according  
to claim 8, wherein the acicular crystals comprise tin  
oxide.

15 12. The photoelectric conversion device according  
to claim 1, wherein a part of the acicular crystals  
exists in fine pores of a finely porous layer having a  
number of fine pores.

20 13. A method of producing a photoelectric  
conversion device which comprises at least an electron  
acceptive charge transfer layer, an electron donative  
charge transfer layer, and a light absorption layer  
25 existing between the charge transfer layers, the method  
comprising applying a solution containing acicular  
crystals on a substrate and firing the substrate to

form a semiconductor acicular crystal layer comprising aggregate of acicular crystal on the substrate and utilizing the semiconductor acicular crystal layer as either one of the charge transfer layers.

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14. A method of producing a photoelectric conversion device which comprises at least an electron acceptive charge transfer layer, an electron donative charge transfer layer, and a light absorption layer  
10 existing between the charge transfer layers, the method comprising forming a semiconductor acicular crystal layer comprising aggregate of acicular crystals on a substrate by a CVD process and utilizing the semiconductor acicular crystal layer as either one of  
15 the charge transfer layers.

15. The method of producing a photoelectric conversion device according to claim 14, comprising the steps of providing an aluminium layer on a surface of  
20 the substrate, anodizing the aluminium layer to form a finely porous alumina layer, and growing the semiconductor acicular crystals through the alumina fine pores by a CVD process.

25 16. A method of producing a photoelectric conversion device which comprises at least an electron acceptive charge transfer layer, an electron donative

charge transfer layer, and a light absorption layer existing between the charge transfer layers, the method comprising oxidizing a surface of a substrate to form a semiconductor acicular crystal layer comprising  
5 aggregate of acicular crystals on the substrate and utilizing the semiconductor acicular crystal layer as either one of the charge transfer layers.

17. The method of producing a photoelectric  
10 conversion device according to claim 16, comprising the steps of providing an aluminium layer on a surface of the substrate, anodizing the aluminium layer to form a finely porous alumina layer, and oxidizing at least a part of the substrate to grow the semiconductor  
15 acicular crystals through the alumina fine pores.

18. The method of producing a photoelectric conversion device according to claim 16, wherein a substrate comprising any one of titanium, zinc, and tin  
20 at least in the surface is used as the substrate.

19. The method of producing a photoelectric conversion device according to claim 13 or 16, wherein a substrate having an electrode on the surface thereof  
25 is used as the substrate.

20. A photoelectric conversion device comprising

at least an electron acceptive charge transfer layer,  
an electron donative charge transfer layer, and a light  
absorption layer existing between the charge transfer  
layers, wherein either one of the charge transfer  
5 layers is a semiconductor layer comprising a mixture  
with two or more kinds of different morphologies or  
compositions and at least one of the kinds of the  
semiconductor layer is an acicular crystal.

10 21. The photoelectric conversion device according  
to claim 20, wherein the diameter of the acicular  
crystal is 1  $\mu\text{m}$  or less.

22. The photoelectric conversion device according  
15 to claim 20, wherein the aspect ratio is 5 or more when  
the aspect ratio is defined as the ratio of the length  
to the diameter of the acicular crystal or as the ratio  
of the length of the acicular crystal to the length of  
a shortest line in a transverse cross-section passing  
20 the gravity center of the acicular crystal.

23. The photoelectric conversion device according  
to claim 20, wherein an aspect ratio is 10 or more when  
the aspect ratio is defined as the ratio of the length  
25 to the diameter of the acicular crystal or as the ratio  
of the length of the acicular crystal to the length of  
a shortest line in a transverse cross-section passing

the gravity center of the acicular crystal.

24. The photoelectric conversion device according to claim 20, wherein one end of the acicular crystal is  
5 bonded to an electrode provided on a substrate and the angle formed between the axial direction of the acicular crystal and the principal plane of the substrate is 60° or more.

10 25. The photoelectric conversion device according to claim 20, wherein the semiconductor other than the acicular crystal in the mixture is a fine particle with a diameter of 100 nm diameter or less.

15 26. The photoelectric conversion device according to claim 25, wherein the fine particle exists on a surface of the acicular crystal.

20 27. The photoelectric conversion device according to claim 20, wherein the material of the light absorption layer is dye.

25 28. The photoelectric conversion device according to claim 20, wherein the mixture comprises a metal oxide.

29. The photoelectric conversion device according

to claim 28, wherein at least one kind of the mixture is titanium oxide.

30. The photoelectric conversion device according  
5 to claim 28, wherein at least one kind of the mixture is zinc oxide.

31. The photoelectric conversion device according  
to claim 28, wherein at least one material of the  
10 mixture is tin oxide.

32. The photoelectric conversion device according  
to claim 20, wherein a part of the acicular crystal  
exists in a fine pore of a finely porous layer having a  
15 number of fine pores.

33. A method of producing a photoelectric  
conversion device which comprises at least an electron  
acceptive charge transfer layer, an electron donative  
20 charge transfer layer, and a light absorption layer  
existing between the charge transfer layers, the method  
comprising applying a semiconductor mixture solution  
comprising a semiconductor mixture with two or more  
kinds of different morphologies or compositions on a  
25 substrate and firing the substrate to form a  
semiconductor mixed crystal layer on the substrate, and  
utilizing the semiconductor mixed crystal layer as



either one of the charge transfer layers.

34. A method of producing a photoelectric conversion device which comprises at least an electron  
5 acceptive charge transfer layer, an electron donative charge transfer layer, and a light absorption layer existing between the charge transfer layers, the method comprising the steps of applying a solution containing a semiconductor acicular crystal on a substrate and  
10 firing the substrate to form an acicular semiconductor crystal layer, further depositing a single substance or a mixture with a different morphology or composition from that of the acicular crystal to the semiconductor layer to form a semiconductor mixed crystal layer on  
15 the substrate, and utilizing the semiconductor mixed crystal layer as either one of the charge transfer layers.

35. A method of producing a photoelectric  
20 conversion device which comprises at least an electron acceptive charge transfer layer, an electron donative charge transfer layer, and a light absorption layer existing between the charge transfer layers, the method comprising the steps of growing an acicular crystal on  
25 a substrate, depositing to the acicular crystal a single substance or a mixture with a different morphology or composition from that of the acicular

crystal to form a semiconductor mixed crystal layer on the substrate, and utilizing the semiconductor mixed crystal layer as either one of the charge transfer layers.

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36. The method of producing a photoelectric conversion device according to claim 35, comprising the step of growing the acicular crystal on the substrate by a CVD process.

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37. The method of producing a photoelectric conversion device according to claim 36, comprising the steps of forming an aluminium layer on a surface of the substrate, anodizing the aluminium layer to form a  
15 finely porous alumina layer, and growing a semiconductor acicular crystal through the fine pores of the finely porous alumina layer by a CVD process.

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38. The method of producing a photoelectric conversion device according to claim 35, comprising the step of oxidizing a surface of the substrate to grow the acicular crystal on the substrate.

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39. The method of producing a photoelectric conversion device according to claim 38, comprising the steps of forming an aluminium layer on the surface of the substrate, anodizing the aluminium layer to form a

finely porous alumina layer, and oxidizing at least a part of the substrate to grow a semiconductor acicular crystal through the fine pores of the finely porous alumina layer.

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40. The method of producing a photoelectric conversion device according to any one of claims 35 to 39, wherein a substrate comprising any one of titanium, zinc, and tin in at least a surface thereof is used as  
10 the substrate.

41. The method of producing a photoelectric conversion device according to any one of claims 33 to 35, wherein a substrate having an electrode on a  
15 surface thereof is used as the substrate.